§15. Analysis for Plasma Wall Interactions in LHD Using Material Probes

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Control of plasma-wall interactions is a key issue for the improvement of the plasma parameter toward to commercial helical-type fusion reactor so that the interactions in the present device must be investigated and improved. We have investigated the toroidal and poloidal distributions of impurity deposition and gas retention using material probes and have discussed the deposition/retention mechanism so far. For long-term plasma discharges in future, the introductions of radiation damages and the gas implantation would become egregious, which would lead to the significant change of the plasma-wall interactions. In the present study, material probes with helium pre-irradiation was exposed to plasmas during 16th campaigns in the LHD. The impurity deposition and gas retention/desorption properties of the exposed probes were investigated.

The material probes made of silicon and SS316L were used for the evaluations of impurity deposition and retention/desorption properties, respectively. In addition, the SS probes pre-irradiated by helium ions at RT or 200°C were used. The pre-irradiations were conducted using a glow discharge apparatus[1)]. The change of the irradiation temperature would result in the change of size and distribution of introduced damages. These probes were installed on first walls at #3, #7 and #8 sectors in the LHD, then exposed to plasmas during the 16th experimental campaign. After the campaign, the probes was taken out and then analyzed. The impurity deposition were evaluated by means of Auger electron spectroscopy, and the hydrogen retention was evaluated by means of thermal desorption spectroscopy.

Carbon deposition with thickness of (5-10) nm were observed for the surfaces of all silicon probes. Carbon emission from divertor tiles and subsequent re-deposition were responsible for the carbon deposition. Figure 1 shows thermal desorption spectra of hydrogen for the SS probes installed on first wall in #3 sector. The hydrogen desorption during the thermal desorption measurement were mainly observed in the range from 600 to 1100K. The desorption rates for the helium pre-irradiated probes were smaller than those for the probes without the pre-irradiation. In addition, the peak temperatures for the pre-irradiated probes were different from those for the probes without pre-irradiation. These changes were distinguished in the probes with the high pre-irradiation temperature. The pre-irradiation would cause the change in size and distribution of the defects in the probes, which would resulted in the changes of trapping energy for hydrogen.

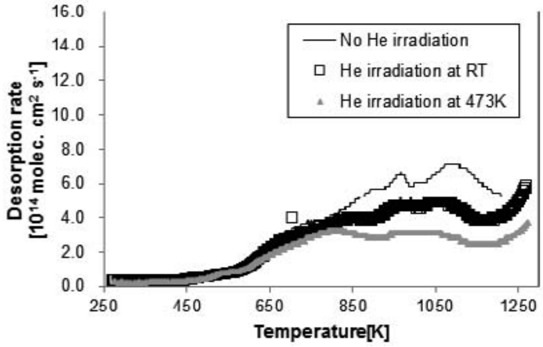

Fig. 1. Thermal desorption spectra of hydrogen for SS probes with and without helium pre-irradiation installed on first wall in #3 sector.

Figure 2 shows amount of retained hydrogen for the SS probes installed on first wall in #3 sector. The amount of retained hydrogen for the pre-irradiated probes were smaller than that for the probe without the pre-irradiation. The increase of pre-irradiation temperature resulted in the low hydrogen retention. Similar results were observed for the probes located at other positions. The small retention might be owing to the suppression of hydrogen inward diffusion by radiation damage formed during the pre-irradiation and/or helium trapping in intrinsic trapping sites for hydrogen.

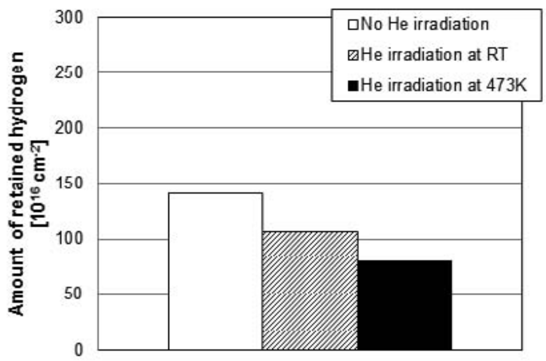

Fig. 2. Amount of retained hydrogen for SS probes with and without helium pre-irradiation installed on first wall in #3 sector.

1) Yamauchi, Y. et al. : J. Nucl. Meter. **390-391** (2009) 1048.